

Absolute Frequency Measurement of the 190μ and 194μ

Gas Laser Transitions*

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The successful CW operation of D_2O and C_2N_2 submillimeter laser at 190μ and 194μ ⁽¹⁾ has been recently reported by W. M. Müller and G. T. Flesher. We wish to report the measurement of the frequencies of these lines, which fall in the 1500 Ghz region. This was accomplished by the mixing of high order harmonics of a V-band Klystron's output with the laser signal. These measurements constitute the highest laser frequencies measured to date. Previous frequency measurements of far infrared laser transitions were done at 311μ and 337μ corresponding to 964 and 890 Ghz respectively.⁽²⁾

The laser used in this experiment was two meters long and 2" in diameter and employed a near confocal mirror configuration. The laser radiation was coupled out through an $1/8$ " hole in one of the mirrors. Part of the output beam was split off by a crystal quartz beam splitter and analyzed by a $1/2$ meter spectrometer and Golay cell. This proved to be a convenient arrangement for optimising and monitoring the laser output power at the two specific wavelengths. The

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frequency measurement was made by mixing the laser output with the 22nd and 23rd harmonics of a 70 Ghz V-band Klystron in a commercial V-to G-band cross guide harmonic mixer. This mixer employed a silicon crystal and tungston cat whisker and was similar to the one used in the measurement of the 337μ and 311μ "cyanide" lines. (2)

The V-band Klystron was phase-locked to the 7th harmonic of an X-band Klystron which was in turn locked to a tunable cavity. Therefore by slowly tuning the X-band cavity, the frequency of the V-band Klystron could be swept.

The output of the harmonic mixer was amplified by an 80 mhz intermediate frequency amplifier with a 1 Mhz bandwidth and then rectified. Further narrow banding was achieved by chopping the laser output at an audio frequency and using a phase-sensitive detector. While the X-band cavity was tuned, the output of the detector was displayed on a strip chart recorder. Figure 1 shows a recorder trace for the 194μ line.

The size of the rectified laser signal across the silicon diode of the harmonic mixer varied widely with the cat whisker contact. Signals larger than one millivolt were obtained, however, a large rectified signal did not necessarily imply a good contact for harmonic frequency mixing.

By tuning the laser interferometer, the laser frequency could be tuned over a range of several Mhz but the frequency of the laser was set

to the line center of the laser transition within 1 Mhz for this measurement. The measured frequencies of this transition line centers were 1578.279 Ghz and 1539.756 Ghz corresponding to vacuum wavelengths of 189.949 μ and 194.702 μ respectively.⁽³⁾ The estimated error of 1.5 Mhz arises principally from the uncertainty in the transition line center.

Frequency measurements of submillimeter laser transitions produce much needed frequency and wavelength standards in this region and are an important step toward a more precise measurement of the speed of light.

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References

1. W. M. Muller and G. T. Flesher, Appl. Phys. Lett., 3, 10 (1967).
2. L. O. Hocker, A. Javan, D. Ramachandra Rao, L. Frenkel, and T. Sullivan, Appl. Phys. Letts., 3, 8 (1967).
3. The value of the speed of light used in this calculation is 2.99793×10^{10} cm/sec.

FIGURE CAPTIONS

Figure 1: Recorder tracing showing 194 μ laser versus V-band harmonic heterodyne signal.

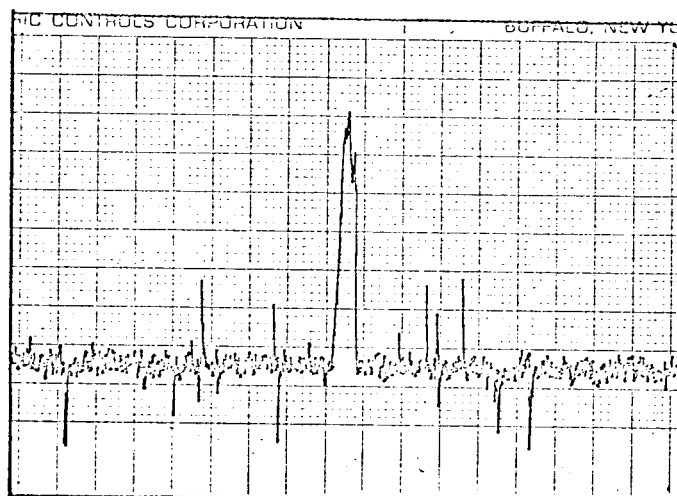


Fig. 1

ABSTRACT

By harmonic mixing with a 70 Ghz source, the frequencies of the 190 and 194 μ laser transitions in a D₂O and C₂N₂ discharge have been measured as 1578.279 and 1539.756 Ghz.